

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

LISTING OF CLAIMS:

1. (Currently Amended) A process for forming a carbon- and transition metal-containing film on a surface of a substrate, comprising the following process steps:

- (a) placing the substrate into a reaction space;
- (b) introducing a first chemical into the reaction space such that at least a portion of the first chemical is adsorbed onto the substrate surface;
- (c) after introducing the first chemical, purging the reaction space;
- (d) introducing a second chemical into the reaction space such that at least a portion of the second chemical reacts with the adsorbed first chemical, wherein the first chemical is one of a transition metal ~~chemical~~ halide and an organometallic chemical wherein the metal portion thereof is selected from the group consisting of aluminum, gallium, and transition metal, and the second chemical is the other of [[the]] said transition metal ~~chemical~~ halide and [[the]] said organometallic chemical wherein the metal portion thereof is selected from the group consisting of aluminum, gallium, and transition metal;
- (e) after the introducing said [[the]] second chemical, purging the reaction space; and
- (f) introducing a third chemical into the reaction space, wherein further reaction takes place and the third chemical is the same chemical as the first chemical; and (i) a transition metal halide when the first chemical is a transition

metal halide, or (ii) an organometallic chemical wherein the metal portion thereof is selected from the group consisting of aluminum, gallium and transition metal when the first chemical is an organometallic chemical; and

(g) after introducing the third chemical, purging the reaction space,

~~the organometallic chemical including carbon and a metal, the transition metal chemical and the organometallic chemical reacting together such that carbon from the organometallic chemical and transition metal from the transition metal chemical together form~~ whereby a carbon- and transition metal-containing film is formed on the substrate.

2. (Currently Amended) The process of claim 1, in which ~~[[the]]~~ said first chemical is the transition metal ~~chemical~~ halide and the second chemical is ~~[[the]]~~ said organometallic chemical wherein the metal portion thereof is selected from the group consisting of aluminum, gallium, and transition metal.

3. (Canceled).

4. (Currently Amended) The process of claim 1, in which ~~[[the]]~~ said first chemical is ~~[[the]]~~ said organometallic chemical wherein the metal portion thereof is selected from the group consisting of aluminum, gallium, and transition metal and the second chemical is ~~[[the]]~~ said transition metal ~~chemical~~ halide.

5. (Currently Amended) The process of claim 1, in which the carbon- and transition metal-containing film has a thickness and in which steps ~~(b)-(e) comprise a first cycle, and in which the first cycle is repeated~~ (d)-(g) are further carried out one or more times following step (g) to increase the thickness of the carbon- and transition metal-containing film wherein at least a portion of the third chemical reacts with the second chemical.

6. (Currently Amended) The process of claim 5, in which ~~the first cycle is repeated~~ process steps (d)-(g) are further carried out between 1 and 10,000 times.

7. (Canceled).

8. (Canceled).

9. (Currently Amended) The process of claim ~~[[8]]~~ 1, in which ~~[[the]]~~ said transition metal halide is a chloride.

10. (Currently Amended) The process of claim ~~[[7]]~~ 1, in which the transition metal portion of said transition metal halide is selected from the group consisting of titanium, zirconium, hafnium, vanadium, niobium, tantalum, chromium, molybdenum, and tungsten.

11. (Currently Amended) The process of claim 1, in which the transition metal chemical halide is selected from the group consisting of titanium trichloride, titanium

tetrachloride, titanium tetraiodate, zirconium tetrachloride, zirconium tetraiodate, hafnium tetrachloride, hafnium tetraiodate, niobium pentachloride, tantalum pentachloride, molybdenum pentachloride, tungsten hexachloride, and tungsten hexafluoride.

12. (Currently Amended) The process of claim 1, in which ~~[[the]]~~ said transition metal ~~chemical~~ halide includes a mixture of transition metal ~~chemicals~~ halides including at least two different transition metals.

13. (Currently Amended) The process of claim 12, in which each of ~~[[the]]~~ said at least two different transition metals in the mixture of transition metal ~~chemicals~~ halides is present in a proportion of at least 1 atomic percent.

14. (Currently Amended) The process of claim 12, in which ~~[[the]]~~ said transition metal ~~chemical~~ halide includes at least two different transition metals that are alternately introduced into the reaction space.

15. (Canceled).

16. (Canceled).

17. (Currently Amended) The process of claim 1, in which the organometallic chemical wherein the metal portion thereof is selected from the group consisting of aluminum, gallium, and transition metal includes an organic portion selected from the

group consisting of an alkyl group ligand and a substituted alkyl ligand.

18. (Previously Presented) The process of claim 17, in which the alkyl group ligand is selected from the group consisting of methyl, ethyl, i-butyl, butyl, i-propyl, and cyclopentadienyl.

19. (Currently Amended) The process of claim 1, in which [[the]] said organometallic chemical is trimethylaluminum.

20. (Currently Amended) The process of claim 1, in which [[the]] said organometallic chemical includes a halide portion.

21. (Currently Amended) The process of claim 20, in which [[the]] said organometallic chemical is dimethylaluminum chloride.

22. (Currently Amended) The process of claim 1, in which ~~the transition metal chemical includes a transition metal portion and a non-metal portion and the organometallic chemical includes an organic portion and a metal portion, and the~~ metal portions of [[the]] said organometallic chemical and [[the]] said transition metal chemical halide are the same metal.

23. (Original) The process of claim 1, in which the substrate includes a previously formed film.

24. (Original) The process of claim 23, in which the previously formed film is patterned.

25. (Currently Amended) The process of claim 1, in which the substrate is placed into the reaction space such that both sides of the substrate are exposed to ~~[[the]]~~ said first and second chemicals.

26. (Original) The process of claim 1, in which the substrate is positioned in the reaction space such that it is at least partially shielded to hinder formation of the carbon- and transition metal-containing film on at least a portion of the substrate.

27. (Original) The process of claim 1, in which more than one substrate is placed into the reaction space such that the carbon- and transition metal-containing film forms on at least one surface of each substrate.

28. (Currently Amended) The process of claim 1, in which ~~the transition metal chemical includes a transition metal portion and a non-metal portion and the organometallic chemical includes an organic portion and a metal portion, and the metal portions of~~ ~~[[the]]~~ said organometallic chemical and ~~[[the]]~~ said transition metal ~~chemical~~ halide are different metals.

29. (Previously Presented) The process of claim 1, in which the purging of the reaction space includes purging with an inert gas selected from the group consisting of nitrogen, helium, neon, argon, carbon dioxide, and mixtures thereof.

30. (Previously Presented) The process of claim 1, in which the substrate is selected from the group consisting of glass, silica, silicon, metals, alloys, fibers, ceramics, porous materials, mixtures thereof, and layers thereof.

31. (Original) The process of claim 1, in which the reaction space is operated at atmospheric pressure.

32. (Original) The process of claim 1, in which the reaction space is operated at a pressure that is less than atmospheric pressure.

33. (Original) The process of claim 1, in which the reaction space is operated at a pressure that is between about 0.1 mbar and about 50 mbars.

34. (Original) The process of claim 1, in which the reaction space is heated.

35. (Original) The process of claim 1, in which the reaction space is operated at a temperature that is between about 150°C and about 600°C.

36. (Original) The process of claim 1, in which the reaction space is operated at a temperature that is between about 250°C and about 550°C.

37. (Original) The process of claim 1, in which the reaction space is within an atomic layer deposition reactor.

38. (Canceled).

39. (Currently Amended) The process of claim [38] 79, ~~in which the first cycle and the second cycle are performed~~ wherein two different transition metals are introduced in a ratio of between 50:1 and about 1:50.

40. (Canceled).

41. (Canceled).

42. (Original) The process of claim 1, in which the first chemical adsorbed onto the substrate surface forms a monolayer.

43. (Original) The process of claim 1, in which the first chemical adsorbed onto the substrate surface forms less than a monolayer.

44. (Original) The process of claim 1, in which the carbon- and transition metal-containing film is a transition metal carbide.

45. (Currently Amended) The process of claim 1, in which at least one of the organometallic chemical and the transition metal chemical said first chemical and said second chemical is introduced into the reaction space via an inert carrier gas selected from the group consisting of nitrogen, helium, neon, argon, neon, carbon dioxide, or a mixture thereof.

46. (Currently Amended) The process of claim 1, in which at least one of ~~[[the]]~~ said first chemical ~~or the~~ and said second chemical is in the form of a vapor.

47. (Currently Amended) The process of claim 1, ~~in which the transition metal chemical includes a transition metal portion, and~~ in which the carbon- and transition metal-containing film includes at least 25 atomic percent of the transition metal ~~portion of said transition metal halide.~~

48. (Currently Amended) The process of claim 1, ~~in which the organometallic chemical includes an organic portion and a metal portion, and~~ in which the carbon- and transition metal-containing film includes between about 0 and about 20 atomic percent of the metal ~~portion of said organometallic chemical.~~

49. (Currently Amended) The process of claim 1, ~~in which the transition metal chemical includes a transition metal portion and a non-metal portion and the organometallic chemical includes an organic portion and a metal portion, and~~ in which the carbon- and transition metal-containing film includes at least 25 atomic percent of the transition metal ~~portion of said transition metal halide,~~ at least 30 atomic percent of ~~the organic portion~~ carbon, less than 20 atomic percent of the metal portion ~~from the~~ of said organometallic chemical, and less than 10 atomic percent of an impurity.

50. (Canceled).

51. (Original) The process of claim 1, in which the carbon- and transition metal containing film includes less than 25 atomic percent of a mixture including residual metals and impurities.

52. (Original) The process of claim 1, in which the carbon- and transition metal-containing film includes less than 15 atomic percent of a mixture including halides and impurities.

53. (Original) The process of claim 1, in which the carbon- and transition metal-containing film includes less than 10 atomic percent of a nitrogen-containing impurity.

54. (Original) The process of claim 1, in which the carbon- and transition metal-containing film has a nonuniformity of sheet resistance that is less than 20%.

55. (Original) The process of claim 1, in which the carbon- and transition metal containing film is deposited by an atomic layer deposition method.

56. (Original) The process of claim 1, in which the carbon- and transition metal containing film is patterned.

57. (Currently Amended) The process of claim 1, in which the transition metal ~~chemical~~ halide reacts with the surface of the substrate to form a surface bound transition metal complex.

58. (Previously Presented) The process of claim 1, in which the carbon- and transition metal-containing film is selected from the group consisting of titanium carbide, zirconium carbide, hafnium carbide, niobium carbide, tantalum carbide, molybdenum carbide, and tungsten carbide.

59. (Original) The process of claim 1, in which an inert gas flows through the reaction space.

60. (Original) The process of claim 1, in which the carbon- and transition metal containing film has a film thickness nonuniformity of less than 20%.

61. (Original) The process of claim 1, further comprising depositing by atomic layer deposition a layer of a metal nitride, silicon nitride, or germanium nitride film.

62. (Original) The process of claim 1, further comprising depositing by atomic layer deposition a layer of a metal oxide, silicon oxide, or germanium oxide film.

63. (Original) The process of claim 1, further comprising depositing by atomic layer deposition a layer of a metal, silicon, or germanium film.

64. (Withdrawn) A carbon- and transition metal-containing film produced by the process of claim 1.

65. (Withdrawn) The carbon- and transition metal-containing film of claim 64, in which the film forms one of the group consisting of a conductive diffusion barrier, a corrosion protection layer, a chemical reaction catalyst, a hard wear-resistant coating, an etch stopper for use in a patterning process, a dielectric film, a conductive film, and a diffusion barrier layer.

66. (Cancelled).

67. (Cancelled).

68. (Cancelled).

69. (Withdrawn) A reactor for forming a carbon- and transition metal-containing film on a surface of a substrate, comprising:

- a reaction space into which the substrate is placed;
- a first source system for delivering to the reaction space a first chemical;
- a second source system for delivering to the reaction space a second chemical, wherein the first chemical is one of a transition metal chemical or an organometallic chemical and the second chemical is the other of the transition metal chemical or the organometallic chemical;
- an inert gas flow system for delivering to the reaction space an inert gas;
- a heating system for heating the reaction space; and
- a control system operatively coupled to the first and second source systems for controlling the delivery of the chemicals into the reaction space.

70. (Canceled).

71. (Canceled).

72. (Canceled).

73. (Canceled).

74. (Canceled).

75. (Canceled).

76. (Canceled).

77. (Canceled).

78. (Canceled).

79. (New) The process of claim 1, in which process steps (d)-(e) are carried out one additional time following the final step (g) wherein at least a portion of the second chemical reacts with the third chemical.

80. (New) The process of claim 5, in which process steps (d)-(e) are carried out one additional time following the final step (g) wherein at least a portion of the second chemical reacts with the third chemical.

81. (New) The process of claim 5, wherein during at least one additional sequence of process steps (d)-(g) that is carried out following step (g) said second chemical or said third chemical comprises a different transition metal halide than was introduced in at least one previously conducted step (b) or (d) and wherein at least a portion of the third chemical reacts with the second chemical.

82. (New) The process of claim 79, wherein process steps (d)-(g) are carried out for a plurality of times with said different transition metal halides being introduced in alternating cycles between 1 and 10,000 times.

83. (New) The process of claim 5, wherein during at least one sequence of process steps (d)-(g) said second chemical or said third chemical comprises a different organometallic chemical than was introduced in a previously conducted step (b) or (d).

84. (New) The process of claim 5, wherein during at least one sequence of process steps (d)-(g) said second chemical or said third chemical comprises a different transition metal halide than was introduced in a previously conducted step (b) or (d), and the second or third chemical comprises a different organometallic chemical than was introduced in a previously conducted step (b) or (d).